DEPARTMENT OF ECOLOGY

SOURCE TEST METHOD

METHOD 18, PARTICULATE MEASUREMENT USING AN INTERMEDIATE VOLUME SAMPLER

1. Principle

   Particulate emissions are determined by filtration using an Intermediate Volume Sampler (IVS).

2. Description

   Exhaust gas is withdrawn from a duct approximately isokinetically. The particulate is collected on a glass fiber filter and the sample volume determined by a flowmeter and lapsed time. The concentration is then calculated by dividing the weight of particulate collected by the volume sampled.

3. Equipment

   Sampler -- IVS particulate sampler, as shown in Figure 1 and described in "Particulate Sampling with a Compact Intermediate Volume Sampler" by G.S. Beckwith, APCA-PNWIS, November) 1974. The sampler consists of the following: (a) nozzle, (b) probe with flowmeter and thermocouple (c) filter holder (d) variable speed blower, variable from 2 to 20 cfm, and (e) lapsed time meter.

   Filter -Glass fiber mat filter of pyrex without organic binder (Gelman Type A or equivalent) filter container.

4. Procedure

   After selecting the sampling site, determine the exhaust temperature, moisture and velocity. These values should be measured, but under some conditions, they may be estimated. Using the average velocity determined above, select a nozzle size and pressure drop ($\triangle$h) from Tables 1 to 5 that would result in isokinetic sampling. Ideally, the sampling rate should be between 10 and 20 cfm. Then assemble the sampler as shown in Figure l, placing two pre-weighed filters in the filter holder section. Normally, select three or four sampling points and adjust the sampling rate to the average velocity in the duct. In no case should zero or negative velocity areas be sampled. Drawing clean ambient air through the sampler, set the control switch in the variable mode and quickly adjust to the selected $\in$h and turn off the sampler.

   Zero the lapsed time meter. Insert the nozzle into the gas stream and position the nozzle at the desired sampling point. Then turn the sampler on to the variable mode and adjust to the selected flowmeter pressure drop $\in$h. Sample for a minimum of three minutes and record simultaneous readings of lapsed time, $\triangle$h and sample temperature periodically. Normally, readings are taken every minute, or five readings during the run. If necessary, the sampling should be adjusted to maintain the desired $\triangle$h. Terminate the run if unable to maintain half of the desired $\triangle$h. At the end of the run, record the final elapsed time, $\triangle$h and temperature.

Carefully remove the filters and place them in a pre-weighed container. Also, brush any loose particulate from the nozzle, probe and filter holder into the container.

5. Analysis

Dry the sample in a pre-weighed container at 105^{o}C and desiccate until cool. Then weigh the sample on an analytical balance.

Calculate the sample volume from the product of the sampling rate and the lapsed time. If the sampling rate was not constant, calculate the volume sampled for each increment of lapsed time recorded and add the increments. Then divide the weight of particulate collected by the volume sampled corrected to standard dry conditions.

Fig. 1

SCFM FLOW AND NOZZLE VELOCITY FOR GAS TEMPERATURES AT DEGREES FAHRENHEIT

NOZZ. METER DELTA H	CFM/ FPS 60	CFM/ FPS 90	CFM/ FPS 120	CFM/ FPS 160	CFM/ FPS 210	CFM/ FPS 250	CFM/ FPS 310	CFM/ FPS 360	CFM/ FPS 410	CFM/ FPS 460	CFM/ FPS 510	CFM/ FPS 560	CFM/ FPS 660	CFM/ FPS 760	CFM/ FPS 860	CFM/ FPS 960	CFM/ FPS 1060
.01	2.94 16.01	2.87 16.46	2.79 16.91	2.70 17.48	2.60 18.17	2.50 18.84	2.42 19.48	2.35 20.10	2.28 20.71	2.22 21.29	2.16 21.87	2.10 22.42	2.01 23.50	1.92 24.52	1.85 25.51	1.78 26.46	1.72 27.37
.02	4.17 22.64	4.05 23.28	3.95 23.91	3.82 24.72	3.67 25.70	3.54 26.64	3.42 27.55	3.32 28.43	3.22 29.28	3.13 30.12	3.05 30.92	2.98 31.71	2.84 33.23	2.72 34.68	2.62 36.07	2.52 37.41	2.44 38.71
.03	5.10 27.73	4.95 28.52	4.83 29.29	4.67 30.28	4.50 31.48	4.34 32.63	4.19 33.74	4.06 34.82	3.95 35.87	3.84 36.88	3.74 37.87	3.64 38.84	3.48 40.70	3.33 42.47	3.20 44.18	3.09 45.82	2.99 47.41
.04	5.89 32.02	5.73 32.93	5.58 33.82	5.40 34.96	5.19 36.35	5.01 37.68	4.84 38.96	4.69 40.21	4.56 41.42	4.43 42.59	4.32 43.73	4.21 44.84	4.02 46.99	3.85 49.04	3.70 51.01	3.57 52.91	3.45 54.74
.05	6.59 35.80	6.41 36.82	6.24 37.81	6.03 39.09	5.81 40.63	5.60 42.12	5.42 43.56	5.25 44.95	5.09 46.30	4.95 47.62	4.82 48.89	4.71 50.14	4.49 52.54	4.30 54.83	4.14 57.04	3.99 59.16	3.85 61.20
.06	7.22 39.22	7.02 40.33	6.84 41.42	6.61 42.82	6.36 44.51	6.13 46.14	5.93 47.72	5.75 49.24	5.58 50.72	5.43 52.16	5.29 53.56	5.15 54.92	4.92 57.55	4.71 60.07	4.53 62.48	4.37 64.80	4.22 67.05
.07	7.80 42.36	7.58 43.56	7.39 44.73	7.14 46.25	6.87 48.08	6.63 49.84	6.41 51.54	6.21 53.19	6.03 54.79	5.86 56.34	5.71 57.85	5.57 59.32	5.31 62.16	5.09 64.88	4.89 67.49	4.72 70.00	4.56 72.42
.08	8.34 45.28	8.10 46.57	7.89 47.82	7.63 49.44	7.34 51.40	7.08 53.28	6.85 55.10	6.64 56.86	6.44 58.57	6.27 60.23	6.10 61.85	5.95 63.42	5.68 66.46	5.44 69.36	5.23 72.15	5.04 74.83	4.88 77.42
.09	8.84 48.03	8.60 49.39	8.37 50.72	8.10 52.44	7.79 54.52	7.51 56.52	7.27 58.44	7.04 60.31	6.84 62.12	6.65 63.88	6.47 65.60	6.31 67.27	6.02 70.49	5.77 73.57	5.55 76.52	5.35 79.37	5.17 82.11
.10	9.32 50.63	9.06 52.07	8.82 53.47	8.54 55.28	8.21 57.47	7.92 59.57	7.66 61.61	7.42 63.57	7.20 65.48	7.01 67.34	6.82 69.15	6.65 70.91	6.35 74.30	6.08 77.55	5.85 80.66	5.64 83.66	5.45 86.56
.11	9.77 53.10	9.50 54.61	9.25 56.08	8.95 57.98	8.61 60.27	8.31 62.48	8.03 64.61	7.78 66.68	7.56 68.68	7.35 70.63	7.16 72.52	6.98 74.37	6.66 77.93	6.38 81.33	6.13 84.60	5.91 87.74	5.72 90.78
.12	10.21 55.46	9.93 57.04	9.67 58.57	9.35 60.56	8.99 62.95	8.68 65.26	8.39 67.49	8.13 69.65	7.89 71.73	7.68 73.77	7.47 75.74	7.29 77.67	6.96 81.39	6.66 84.95	6.41 88.35	6.18 91.65	5.97 94.82
.13	10.63 57.72	10.33 59.36	10.06 60.96	9.73 63.03	9.36 65.52	9.03 67.92	8.73 70.24	8.46 72.49	8.21 74.66	7.99 76.78	7.78 78.84	7.59 80.84	7.24 84.71	6.94 88.42	6.67 91.97	6.43 95.39	6.21 98.69
.14	11.03 59.90	10.72 61.61	10.44 63.26	10.10 65.41	9.71 68.00	9.37 70.49	9.06 72.89	8.78 75.22	8.52 77.48	8.29 79.68	8.07 81.81	7.87 83.90	7.51 87.91	7.20 91.75	6.92 95.44	6.67 98.99	6.45 102.41
.15	11.41 62.00	11.10 63.77	10.81 65.48	10.45 67.70	10.06 70.38	9.70 72.96	9.38 75.45	9.09 77.86	8.82 80.20	8.58 82.47	8.36 84.69	8.15 86.84	7.78 91.00	7.45 94.97	7.16 98.79	6.91 102.46	6.68 106.01
.16	11.79 64.04	11.46 65.86	11.16 67.64	10.80 69.93	10.38 72.69	10.02 75.35	9.69 77.93	9.39 80.42	9.11 82.83	8.86 85.18	8.63 87.46	8.42 89.69	8.03 93.98	7.70 98.09	7.40 102.03	7.13 105.82	6.89 109.49
.17	12.15 66.01	11.81 67.89	11.51 69.71	11.13 72.08	10.70 74.93	10.33 77.67	9.99 80.32	9.68 82.89	9.39 85.38	9.13 87.80	8.90 90.15	8.68 92.45	8.28 96.87	7.93 101.11	7.63 105.17	7.35 109.08	7.11 112.86
.18	12.50 67.92	12.16 69.85	11.84 71.73	11.45 74.17	11.01 77.10	10.63 79.92	10.27 82.65	9.96 85.29	9.67 87.86	9.40 90.35	9.15 92.77	8.93 95.13	8.52 99.68	8.16 104.04	7.85 108.22	7.57 112.24	7.31 116.13
.19	12.85 69.78	12.49 71.77	12.16 73.70	11.76 76.20	11.32 79.21	10.92 82.11	10.56 84.92	10.23 87.63	9.93 90.26	9.66 92.82	9.41 95.31	9.17 97.74	8.75 102.41	8.39 106.89	8.06 111.18	7.77 115.32	7.51 119.31
.20	13.18 71.60	12.81 73.63	12.48 75.61	12.07 78.18	11.61 81.27	11.20 84.25	10.83 87.12	10.50 89.91	10.19 92.61	9.91 95.23	9.65 97.79	9.41 100.27	8.98 105.08	8.60 109.67	8.27 114.07	7.98 118.31	7.71 122.41
.22	13.82 75.09	13.44 77.23	13.09 79.31	12.66 81.99	12.18 85.24	11.75 88.36	11.36 91.38	11.01 94.30	10.69 97.13	10.39 99.88	10.12 102.56	9.87 105.17	9.42 110.20	9.02 115.02	8.68 119.64	8.36 124.09	8.08 128.38
.24	14.44 78.43	14.04 80.66	13.67 82.83	13.22 85.64	12.72 89.03	12.27 92.29	11.86 95.44	11.50 98.49	11.16 101.45	10.85 104.32	10.57 107.12	10.31 109.85	9.84 115.10	9.43 120.13	9.06 124.96	8.74 129.61	8.44 134.09
.26	15.03 81.63	14.61 83.95	14.23 86.21	13.76 89.13	13.24 92.66	12.77 96.06	12.35 99.34	11.97 102.51	11.62 105.59	11.30 108.58	11.00 111.49	10.73 114.33	10.24 119.80	9.81 125.04	9.43 130.06	9.09 134.90	8.79 139.57
.28	15.59 84.71	15.16 87.12	14.77 89.47	14.28 92.50	13.74 96.16	13.25 99.68	12.81 103.09	12.42 106.38	12.06 109.58	11.72 112.68	11.42 115.70	11.13 118.65	10.63 124.33	10.13 129.76	9.79 134.97	9.44 139.99	9.12 144.84
.30	16.14 87.69	15.69 90.18	15.28 92.61	14.78 95.75	14.22 99.53	13.72 103.18	13.26 106.72	12.85 110.11	12.48 113.42	12.14 116.64	11.82 119.76	11.52 122.81	11.00 128.69	10.54 134.31	10.13 139.71	9.77 144.90	9.44 149.92
.32	16.67 90.56	16.21 93.14	15.78 95.65	15.27 98.89	14.69 102.80	14.17 106.57	13.70 110.20	13.28 113.73	12.89 117.14	12.53 120.46	12.21 123.69	11.90 126.84	11.36 132.91	10.88 138.72	10.46 144.29	10.09 149.66	9.75 154.84
.34	17.18 93.35	16.71 96.01	16.27 98.59	15.74 101.93	15.15 105.96	14.60 109.85	14.12 113.60	13.68 117.23	13.29 120.75	12.92 124.17	12.58 127.50	12.27 130.74	11.71 137.00	11.22 142.99	10.79 148.73	10.40 154.26	10.05 159.60
.36	17.68 96.05	17.19 98.79	16.74 101.45	16.19 104.89	15.58 109.04	15.03 113.03	14.53 116.89	14.08 120.62	13.67 124.25	13.29 127.77	12.95 131.19	12.63 134.53	12.05 140.97	11.54 147.13	11.10 153.04	10.70 158.74	10.34 164.23
.38	18.17 98.69	17.66 101.50	17.20 104.23	16.64 107.76	16.00 112.02	15.44 116.13	14.93 120.09	14.47 123.93	14.04 127.65	13.66 131.27	13.30 134.79	12.97 138.22	12.38 144.84	11.86 151.16	11.40 157.24	10.99 163.09	10.63 168.73
.40	18.64 101.25	18.12 104.13	17.65 106.94	17.07 110.56	16.42 114.93	15.84 119.14	15.32 123.21	14.84 127.15	14.41 130.97	14.01 134.68	13.65 138.29	13.31 141.81	12.70 148.60	12.17 155.09	11.70 161.32	11.28 167.32	10.90 173.11
.42	19.10 103.75	18.57 106.70	18.08 109.58	17.49 113.29	16.83 117.77	16.23 122.09	15.69 126.25	15.21 130.29	14.77 134.20	14.36 138.01	13.98 141.71	13.64 145.31	13.01 152.27	12.47 158.92	11.99 165.31	11.56 171.45	11.17 177.39
.44	19.55 106.20	19.01 109.22	18.51 112.15	17.90 115.95	17.22 120.53	16.61 124.96	16.06 129.23	15.57 133.36	15.11 137.36	14.70 141.25	14.31 145.04	13.96 148.73	13.32 155.85	12.76 162.66	12.27 169.20	11.83 175.49	11.43 181.56
.46	19.99 [illegible]	19.43 111.67	18.93 [illegible]	18.30 118.56	17.61 123.25	16.99 127.77	16.43 132.14	15.92 137.37	15.45 [illegible]	15.03 144.42	14.63 148.30	14.27 152.07	13.62 159.35	13.05 166.32	12.55 173.01	12.10 179.44	11.69 [illegible]
.48	20.42 [illegible]	19.85 115.02	19.33 117.14	18.70 121.11	17.99 125.92	17.35 130.52	16.78 134.97	16.26 139.29	15.79 143.47	15.35 147.53	14.95 151.49	14.58 155.35	13.91 162.78	13.33 169.89	12.81 176.72	12.36 183.29	11.94 [illegible]
.50	20.84 113.20	20.26 116.42	19.73 119.56	19.08 123.61	18.36 128.50	17.71 133.21	17.12 137.76	16.59 142.16	16.11 [illegible]	15.67 150.58	15.26 154.61	14.88 158.55	14.20 166.14	13.60 173.40	13.08 [illegible]	12.61 [illegible]	12.19 [illegible]
.52	21.25 [illegible]	20.66 118.73	20.12 121.93	19.46 126.06	18.72 131.05	18.06 135.85	17.46 140.49	16.92 144.97	16.43 149.33	15.98 153.56	15.56 157.68	15.17 161.69	14.48 169.43	13.87 176.83	13.34 183.93	12.86 [illegible]	12.43 [illegible]
.54	21.66 117.65	21.06 120.99	20.51 124.25	19.83 128.46	19.08 133.55	18.40 138.43	17.80 143.16	17.25 147.73	16.74 [illegible]	16.28 156.49	15.86 160.68	15.46 164.77	14.76 172.59	14.14 180.29	13.59 187.44	13.10 [illegible]	12.67 [illegible]
.56	22.05 119.80	21.44 123.21	20.88 126.53	20.20 130.82	19.43 135.99	18.74 140.97	18.12 145.79	17.56 150.45	17.05 [illegible]	16.58 159.35	16.15 163.61	15.75 167.79	15.03 175.82	14.40 183.51	13.84 190.88	13.35 [illegible]	12.90 [illegible]

Fig. 2

IVS SAMPLING RATE AND NOZZLE VELOCITY FOR 1.00 INCH DIAMETER NOZZLE
SCFM FLOW AND NOZZLE VELOCITY FOR GAS TEMPERATURES AT DEGREES FAHRENHEIT

FLOW METER DELTA P	CFM/ FPS 60	CFM/ FPS 90	CFM/ FPS 120	CFM/ FPS 160	CFM/ FPS 210	CFM/ FPS 260	CFM/ FPS 310	CFM/ FPS 360	CFM/ FPS 410	CFM/ FPS 460	CFM/ FPS 510	CFM/ FPS 560	CFM/ FPS 660	CFM/ FPS 760	CFM/ FPS 860	CFM/ FPS 960	CFM/ FPS 1060
.01	2.99	2.87	2.79	2.70	2.60	2.50	2.42	2.35	2.28	2.22	2.16	2.10	2.01	1.92	1.85	1.78	1.72
	9.61	9.26	9.51	9.83	10.22	10.60	10.96	11.31	11.65	11.98	12.30	12.61	13.22	13.79	14.35	14.88	15.40
.02	4.17	4.05	3.95	3.82	3.67	3.54	3.42	3.32	3.22	3.13	3.05	2.98	2.84	2.72	2.62	2.52	2.44
	12.78	13.10	13.45	13.91	14.46	14.99	15.50	15.99	16.47	16.94	17.39	17.84	18.69	19.51	20.29	21.05	21.77
.03	5.10	4.96	4.83	4.67	4.50	4.34	4.19	4.06	3.95	3.84	3.74	3.64	3.48	3.33	3.20	3.09	2.99
	15.69	16.04	16.47	17.03	17.71	18.35	18.93	19.59	20.18	20.75	21.30	21.85	22.89	23.89	24.85	25.78	26.67
.04	5.87	5.73	5.58	5.40	5.19	5.01	4.84	4.69	4.56	4.43	4.32	4.21	4.02	3.85	3.70	3.57	3.45
	18.01	18.52	19.02	19.67	20.44	21.19	21.92	22.62	23.30	23.96	24.60	25.22	26.43	27.59	28.70	29.76	30.79
.05	6.59	6.41	6.24	6.03	5.81	5.60	5.42	5.25	5.09	4.95	4.82	4.71	4.49	4.30	4.14	3.99	3.85
	20.14	20.71	21.27	21.99	22.86	23.69	24.50	25.29	26.05	26.78	27.50	28.20	29.55	30.84	32.09	33.28	34.43
.06	7.22	7.02	6.84	6.61	6.36	6.13	5.93	5.75	5.58	5.43	5.29	5.15	4.92	4.71	4.53	4.37	4.22
	22.06	22.69	23.30	24.09	25.04	25.96	26.84	27.70	28.53	29.34	30.13	30.89	32.37	33.79	35.14	36.45	37.71
.07	7.80	7.58	7.38	7.14	6.87	6.63	6.41	6.21	6.03	5.86	5.71	5.57	5.31	5.09	4.89	4.72	4.56
	23.83	24.50	25.16	26.02	27.04	28.04	28.99	29.92	30.82	31.69	32.54	33.37	34.97	36.49	37.96	39.37	40.74
.08	8.34	8.10	7.89	7.63	7.34	7.08	6.85	6.64	6.44	6.27	6.10	5.95	5.68	5.44	5.23	5.05	4.88
	25.47	26.20	26.90	27.81	28.91	29.97	30.99	31.99	32.95	33.88	34.79	35.67	37.38	39.01	40.58	42.09	43.55
.09	8.84	8.60	8.37	8.10	7.79	7.51	7.27	7.04	6.84	6.65	6.47	6.31	6.02	5.77	5.55	5.35	5.17
	27.02	27.79	28.53	29.50	30.67	31.79	32.88	33.93	34.94	35.93	36.90	37.84	39.65	41.38	43.04	44.64	46.19
.10	9.32	9.06	8.82	8.53	8.21	7.92	7.66	7.42	7.20	7.01	6.82	6.65	6.35	6.08	5.85	5.64	5.45
	28.48	29.29	30.08	31.10	32.32	33.51	34.65	35.76	36.83	37.88	38.89	39.88	41.79	43.62	45.37	47.06	48.69
.11	9.77	9.50	9.25	8.95	8.61	8.31	8.03	7.78	7.56	7.35	7.16	6.98	6.66	6.38	6.13	5.91	5.72
	29.87	30.72	31.54	32.61	33.90	35.14	36.34	37.51	38.63	39.73	40.79	41.83	43.83	45.75	47.59	49.36	51.06
.12	10.21	9.93	9.67	9.35	8.99	8.68	8.39	8.13	7.89	7.68	7.47	7.29	6.96	6.66	6.41	6.18	5.97
	31.20	32.08	32.95	34.06	35.41	36.71	37.96	39.17	40.35	41.49	42.61	43.69	45.78	47.78	49.70	51.55	53.33
.13	10.63	10.33	10.06	9.73	9.36	9.03	8.73	8.46	8.21	7.99	7.78	7.59	7.24	6.94	6.67	6.43	6.21
	32.47	33.39	34.29	35.45	36.86	38.21	39.51	40.77	42.00	43.19	44.35	45.47	47.65	49.73	51.73	53.66	55.51
.14	11.03	10.72	10.44	10.10	9.71	9.37	9.06	8.78	8.52	8.29	8.07	7.87	7.51	7.20	6.92	6.67	6.45
	33.70	34.65	35.59	36.79	38.25	39.65	41.00	42.31	43.58	44.82	46.02	47.19	49.45	51.61	53.68	55.68	57.61
.15	11.41	11.10	10.81	10.45	10.06	9.70	9.38	9.09	8.82	8.58	8.36	8.15	7.78	7.45	7.16	6.91	6.68
	34.88	35.87	36.81	38.09	39.59	41.03	42.44	43.80	45.11	46.39	47.64	48.85	51.19	53.42	55.57	57.64	59.63
.16	11.77	11.46	11.16	10.80	10.38	10.02	9.69	9.39	9.11	8.86	8.63	8.42	8.03	7.70	7.40	7.13	6.89
	36.02	37.05	38.04	39.33	40.89	42.39	43.83	45.23	46.59	47.91	49.20	50.45	52.87	55.17	57.39	59.53	61.59
.17	12.15	11.81	11.51	11.13	10.70	10.33	9.99	9.68	9.39	9.14	8.90	8.68	8.28	7.93	7.63	7.35	7.11
	37.13	38.19	39.21	40.54	42.15	43.69	45.18	46.63	48.03	49.39	50.71	52.00	54.49	56.87	59.16	61.36	63.48
.18	12.50	12.16	11.84	11.45	11.01	10.63	10.27	9.96	9.67	9.40	9.15	8.93	8.52	8.16	7.85	7.57	7.31
	38.21	39.27	40.35	41.72	43.37	44.96	46.49	47.98	49.42	50.82	52.18	53.51	56.07	58.52	60.87	63.14	65.32
.19	12.85	12.49	12.16	11.76	11.32	10.92	10.56	10.23	9.93	9.66	9.41	9.17	8.75	8.39	8.06	7.77	7.51
	39.25	40.37	41.46	42.86	44.56	46.19	47.77	49.29	50.77	52.21	53.61	54.98	57.61	60.13	62.54	64.87	67.11
.20	13.18	12.81	12.47	12.07	11.61	11.20	10.83	10.50	10.19	9.91	9.65	9.41	8.98	8.60	8.27	7.98	7.71
	40.27	41.42	42.53	43.98	45.71	47.39	49.01	50.57	52.09	53.57	55.00	56.40	59.10	61.69	64.17	66.55	68.86
.22	13.82	13.44	13.09	12.66	12.18	11.75	11.36	11.01	10.69	10.39	10.12	9.87	9.42	9.02	8.69	8.36	8.09
	42.24	43.44	44.61	46.12	47.95	49.70	51.40	53.04	54.63	56.18	57.69	59.16	61.99	64.70	67.30	69.80	72.22
.24	14.44	14.04	13.67	13.22	12.72	12.27	11.86	11.50	11.16	10.85	10.57	10.31	9.84	9.43	9.06	8.74	8.44
	44.12	45.37	46.59	48.17	50.08	51.91	53.68	55.40	57.06	58.69	60.25	61.79	64.75	67.57	70.29	72.90	75.43
.26	15.03	14.61	14.23	13.76	13.24	12.77	12.35	11.97	11.62	11.30	11.00	10.73	10.24	9.81	9.43	9.09	8.79
	45.92	47.22	48.50	50.14	52.12	54.03	55.88	57.66	59.39	61.08	62.72	64.31	67.39	70.33	73.16	75.88	78.51
.28	15.59	15.16	14.77	14.28	13.74	13.25	12.81	12.42	12.06	11.72	11.42	11.13	10.63	10.18	9.79	9.44	9.12
	47.65	49.01	50.33	52.03	54.09	56.07	57.99	59.84	61.64	63.38	65.08	66.74	69.93	72.99	75.92	78.75	81.47
.30	16.14	15.69	15.28	14.78	14.22	13.72	13.26	12.85	12.48	12.14	11.82	11.53	11.00	10.54	10.13	9.77	9.44
	49.32	50.73	52.09	53.86	55.99	58.04	60.02	61.94	63.80	65.61	67.37	69.08	72.39	75.55	78.58	81.51	84.33
.32	16.67	16.21	15.78	15.27	14.69	14.17	13.70	13.28	12.89	12.53	12.21	11.90	11.36	10.88	10.46	10.09	9.75
	50.94	52.39	53.80	55.63	57.82	59.94	61.99	63.97	65.89	67.76	69.58	71.35	74.76	78.03	81.16	84.18	87.10
.34	17.18	16.71	16.27	15.74	15.14	14.60	14.12	13.68	13.29	12.92	12.58	12.27	11.71	11.22	10.79	10.40	10.05
	52.51	54.00	55.46	57.34	59.60	61.79	63.90	65.94	67.92	69.84	71.72	73.54	77.06	80.43	83.66	86.77	89.78
.36	17.68	17.19	16.74	16.19	15.58	15.03	14.53	14.08	13.67	13.29	12.95	12.63	12.05	11.54	11.10	10.70	10.34
	54.03	55.57	57.06	59.00	61.33	63.58	65.75	67.85	69.89	71.87	73.80	75.67	79.30	82.76	86.09	89.29	92.33
.38	18.17	17.66	17.20	16.64	16.00	15.46	14.93	14.47	14.05	13.66	13.30	12.97	12.38	11.86	11.40	10.99	10.63
	55.51	57.09	58.63	60.62	63.01	65.32	67.55	69.71	71.80	73.84	75.82	77.75	81.47	85.03	88.45	91.74	94.91
.40	18.64	18.12	17.65	17.07	16.42	15.86	15.32	14.84	14.41	14.01	13.65	13.31	12.70	12.17	11.70	11.28	10.90
	56.95	58.57	60.15	62.19	64.65	67.02	69.31	71.52	73.67	75.76	77.79	79.77	83.59	87.24	90.74	94.12	97.38
.42	19.10	18.57	18.08	17.49	16.83	16.23	15.69	15.21	14.77	14.36	13.98	13.64	13.01	12.47	11.99	11.56	11.17
	58.36	60.02	61.64	63.73	66.25	68.67	71.02	73.29	75.49	77.63	79.71	81.74	85.65	89.39	92.98	96.43	99.78
.44	19.55	19.01	18.51	17.90	17.22	16.61	16.06	15.57	15.11	14.70	14.31	13.96	13.32	12.76	12.27	11.83	11.43
	59.71	61.43	63.09	65.23	67.81	70.29	72.69	75.01	77.27	79.45	81.59	83.66	87.67	91.50	95.17	98.71	102.13
.46	19.99	19.43	18.92	18.30	17.61	16.98	16.43	15.92	15.45	15.03	14.63	14.27	13.62	13.05	12.55	12.10	11.69
	61.08	62.81	64.50	66.69	69.33	71.87	74.32	76.70	79.03	81.29	83.42	85.55	89.68	94.52	97.31	100.93	104.42
.48	20.42	19.85	19.33	18.70	17.99	17.35	16.78	16.26	15.79	15.35	14.95	14.58	13.91	13.33	12.81	12.36	11.94
	62.39	64.17	65.89	68.13	70.82	73.42	75.93	78.35	80.73	82.99	85.21	87.38	91.56	95.57	99.40	103.10	106.67
.50	20.84	20.26	19.73	19.08	18.36	17.71	17.13	16.59	16.11	15.67	15.26	14.88	14.20	13.60	13.08	12.61	12.19
	63.68	65.50	67.25	69.53	72.29	74.93	77.49	79.96	82.37	84.70	86.97	89.19	93.45	97.54	101.45	105.21	108.82
.52	21.25	20.66	20.12	19.46	18.72	18.06	17.46	16.92	16.43	15.98	15.57	15.17	14.48	13.87	13.34	12.86	12.43
	64.95	66.79	68.58	70.91	73.73	76.41	79.02	81.56	84.03	86.38	88.69	90.95	95.30	99.47	103.46	107.31	111.03
.54	21.66	21.05	20.51	19.83	19.08	18.40	17.80	17.25	16.74	16.29	15.87	15.46	14.76	14.14	13.60	13.10	12.66
	66.18	68.06	69.89	72.26	75.13	77.87	80.53	83.13	85.66	88.12	90.46	92.78	97.17	101.39	105.43	109.34	113.14
.56	22.06	21.44	21.88	20.20	19.43	18.74	18.12	17.56	17.05	16.59	16.15	15.75	15.03	14.40	13.84	13.35	12.90
	67.41	69.31	71.17	73.59	76.51	79.32	82.03	84.67	87.23	89.73	92.16	94.52	98.99	103.28	107.37	111.30	115.22

Fig. 3

SCFM FLOW AND NOZZLE VELOCITY [illegible]

FLOW NOZZLE DELTA P	CFM/FPS 60	CFM/FPS 90	CFM/FPS 120	CFM/FPS 160	CFM/FPS 210	CFM/FPS 260	CFM/FPS 310	CFM/FPS 360	CFM/FPS 410	CFM/FPS 460	CFM/FPS 510	CFM/FPS 560	CFM/FPS 660	CFM/FPS 760	CFM/FPS 860	CFM/FPS 960	CFM/FPS 1060
.01	2.93 / 4.00	2.87 / 4.12	2.79 / 4.23	2.70 / 4.37	2.60 / 4.54	2.50 / 4.71	2.42 / 4.87	2.35 / 5.03	2.28 / 5.18	2.22 / 5.32	2.15 / 5.47	2.10 / 5.61	2.01 / 5.87	1.92 / 6.13	1.85 / 6.33	1.78 / 6.61	1.72 / 6.84
.02	4.17 / 5.66	4.05 / 5.82	3.95 / 5.98	3.82 / 6.18	3.67 / 6.42	3.54 / 6.66	3.42 / 6.89	3.32 / 7.11	3.22 / 7.32	3.13 / 7.53	3.05 / 7.73	2.98 / 7.93	2.84 / 8.31	2.72 / 8.67	2.62 / 9.02	2.52 / 9.35	2.44 / 9.68
.03	5.10 / 6.91	4.95 / 7.13	4.83 / 7.32	4.67 / 7.57	4.50 / 7.87	4.34 / 8.16	4.19 / 8.44	4.06 / 8.71	3.95 / 8.97	3.84 / 9.22	3.74 / 9.47	3.64 / 9.71	3.48 / 10.17	3.33 / 10.62	3.20 / 11.04	3.09 / 11.46	2.99 / 11.55
.04	5.83 / 8.00	5.73 / 8.23	5.53 / 8.45	5.40 / 8.74	5.19 / 9.09	5.01 / 9.42	4.84 / 9.74	4.69 / 10.05	4.55 / 10.35	4.43 / 10.65	4.32 / 10.93	4.21 / 11.21	4.02 / 11.75	3.85 / 12.26	3.70 / 12.75	3.57 / 13.23	3.45 / 13.69
.05	6.53 / 8.95	6.41 / 9.20	6.23 / 9.45	6.03 / 9.77	5.81 / 10.15	5.60 / 10.53	5.42 / 10.89	5.25 / 11.24	5.09 / 11.58	4.95 / 11.90	4.82 / 12.22	4.71 / 12.53	4.49 / 13.13	4.30 / 13.71	4.14 / 14.26	3.99 / 14.79	3.85 / 15.30
.06	7.22 / 9.80	7.02 / 10.09	6.83 / 10.35	6.61 / 10.71	6.36 / 11.13	6.13 / 11.54	5.93 / 11.93	5.75 / 12.31	5.59 / 12.68	5.43 / 13.04	5.29 / 13.39	5.15 / 13.73	4.92 / 14.39	4.71 / 15.02	4.53 / 15.62	4.37 / 16.20	4.22 / 16.76
.07	7.80 / 10.59	7.58 / 10.89	7.38 / 11.18	7.14 / 11.56	6.87 / 12.02	6.63 / 12.46	6.41 / 12.89	6.21 / 13.30	6.03 / 13.70	5.86 / 14.09	5.71 / 14.46	5.57 / 14.83	5.31 / 15.54	5.09 / 16.22	4.89 / 16.87	4.72 / 17.50	4.56 / 18.10
.08	8.34 / 11.32	8.10 / 11.64	7.89 / 11.96	7.63 / 12.36	7.34 / 12.85	7.08 / 13.32	6.85 / 13.78	6.64 / 14.22	6.44 / 14.64	6.27 / 15.06	6.10 / 15.46	5.95 / 15.85	5.68 / 16.61	5.44 / 17.34	5.23 / 18.04	5.04 / 18.71	4.88 / 19.35
.09	8.84 / 12.01	8.60 / 12.35	8.37 / 12.68	8.10 / 13.11	7.79 / 13.63	7.51 / 14.13	7.27 / 14.61	7.04 / 15.09	6.84 / 15.53	6.65 / 15.97	6.47 / 16.40	6.31 / 16.82	6.02 / 17.62	5.77 / 18.39	5.55 / 19.13	5.35 / 19.84	5.17 / 20.53
.10	9.32 / 12.66	9.06 / 13.02	8.82 / 13.37	8.53 / 13.82	8.21 / 14.37	7.92 / 14.89	7.66 / 15.40	7.42 / 15.89	7.20 / 16.37	7.01 / 16.83	6.82 / 17.29	6.65 / 17.73	6.35 / 18.57	6.08 / 19.39	5.85 / 20.17	5.64 / 20.92	5.45 / 21.64
.11	9.77 / 13.27	9.50 / 13.65	9.25 / 14.02	8.95 / 14.49	8.61 / 15.07	8.31 / 15.62	8.03 / 16.15	7.78 / 16.67	7.56 / 17.17	7.35 / 17.66	7.16 / 18.13	6.98 / 18.59	6.66 / 19.48	6.38 / 20.33	6.13 / 21.15	5.91 / 21.94	5.72 / 22.70
.12	10.21 / 13.85	9.93 / 14.26	9.67 / 14.64	9.35 / 15.14	8.99 / 15.74	8.68 / 16.31	8.39 / 16.87	8.13 / 17.41	7.89 / 17.93	7.68 / 18.44	7.47 / 18.94	7.29 / 19.42	6.96 / 20.35	6.66 / 21.24	6.41 / 22.09	6.18 / 22.91	5.97 / 23.70
.13	10.63 / 14.43	10.33 / 14.84	10.07 / 15.24	9.73 / 15.76	9.36 / 16.38	9.03 / 16.98	8.73 / 17.56	8.46 / 18.12	8.21 / 18.67	7.99 / 19.19	7.78 / 19.71	7.59 / 20.21	7.24 / 21.18	6.94 / 22.10	6.67 / 22.99	6.43 / 23.85	6.21 / 24.67
.14	11.03 / 14.98	10.72 / 15.40	10.44 / 15.82	10.10 / 16.35	9.71 / 17.00	9.37 / 17.62	9.06 / 18.22	8.78 / 18.81	8.52 / 19.37	8.29 / 19.92	8.07 / 20.45	7.87 / 20.97	7.51 / 21.93	7.20 / 22.94	6.92 / 23.86	6.67 / 24.75	6.45 / 25.60
.15	11.41 / 15.50	11.10 / 15.94	10.81 / 16.37	10.45 / 16.91	10.06 / 17.60	9.70 / 18.24	9.38 / 18.86	9.09 / 19.47	8.82 / 20.05	8.58 / 20.62	8.36 / 21.17	8.15 / 21.71	7.78 / 22.75	7.45 / 23.74	7.16 / 24.70	6.91 / 25.62	6.68 / 26.50
.16	11.79 / 16.01	11.45 / 16.46	11.16 / 16.91	10.80 / 17.48	10.38 / 18.17	10.02 / 18.84	9.69 / 19.48	9.39 / 20.10	9.11 / 20.71	8.86 / 21.29	8.63 / 21.87	8.42 / 22.42	8.03 / 23.50	7.70 / 24.52	7.40 / 25.51	7.13 / 26.46	6.89 / 27.37
.17	12.15 / 16.50	11.81 / 16.97	11.51 / 17.43	11.11 / 18.02	10.70 / 18.73	10.33 / 19.42	9.99 / 20.08	9.68 / 20.72	9.39 / 21.35	9.14 / 21.95	8.90 / 22.54	8.68 / 23.11	8.28 / 24.22	7.93 / 25.28	7.63 / 26.29	7.35 / 27.27	7.11 / 28.21
.18	12.50 / 16.94	12.16 / 17.46	11.84 / 17.91	11.45 / 18.59	11.01 / 19.27	10.63 / 19.93	10.27 / 20.66	9.96 / 21.32	9.67 / 21.96	9.40 / 22.59	9.15 / 23.19	8.93 / 23.78	8.52 / 24.92	8.16 / 26.01	7.85 / 27.05	7.57 / 28.06	7.31 / 29.03
.19	12.85 / 17.45	12.49 / 17.94	12.16 / 18.41	11.76 / 19.05	11.32 / 19.80	10.92 / 20.53	10.56 / 21.23	10.23 / 21.91	9.93 / 22.57	9.66 / 23.21	9.41 / 23.83	9.17 / 24.43	8.75 / 25.60	8.39 / 26.72	8.05 / 27.80	7.77 / 28.83	7.51 / 29.83
.20	13.19 / 17.90	12.81 / 18.41	12.48 / 18.90	12.07 / 19.54	11.61 / 20.32	11.20 / 21.06	10.83 / 21.78	10.50 / 22.48	10.19 / 23.15	9.91 / 23.81	9.65 / 24.45	9.41 / 25.07	8.98 / 26.27	8.60 / 27.42	8.27 / 28.52	7.98 / 29.58	7.71 / 30.60
.22	13.82 / 18.77	13.43 / 19.31	13.09 / 19.83	12.66 / 20.50	12.18 / 21.31	11.75 / 22.09	11.36 / 22.84	11.01 / 23.57	10.69 / 24.28	10.39 / 24.97	10.12 / 25.64	9.87 / 26.29	9.42 / 27.55	9.02 / 28.75	8.63 / 29.91	8.35 / 31.02	8.08 / 32.10
.24	14.45 / 19.61	14.04 / 20.17	13.67 / 20.71	13.22 / 21.41	12.72 / 22.26	12.27 / 23.07	11.86 / 23.85	11.50 / 24.62	11.16 / 25.36	10.85 / 26.08	10.57 / 26.78	10.31 / 27.46	9.84 / 28.78	9.43 / 30.03	9.06 / 31.24	8.74 / 32.40	8.44 / 33.52
.26	15.01 / 20.41	14.61 / 20.99	14.23 / 21.55	13.76 / 22.28	13.24 / 23.17	12.77 / 24.01	12.35 / 24.83	11.97 / 25.63	11.62 / 26.40	11.30 / 27.15	11.00 / 27.87	10.73 / 28.58	10.24 / 29.95	9.81 / 31.26	9.43 / 32.52	9.09 / 33.72	8.79 / 34.89
.28	15.59 / 21.18	15.16 / 21.78	14.77 / 22.37	14.28 / 23.13	13.74 / 24.04	13.25 / 24.92	12.81 / 25.77	12.42 / 26.60	12.06 / 27.39	11.72 / 28.17	11.42 / 28.93	11.13 / 29.66	10.63 / 31.03	10.18 / 32.44	9.79 / 33.74	9.44 / 35.00	9.12 / 36.21
.30	16.14 / 21.92	15.69 / 22.55	15.28 / 23.15	14.78 / 23.94	14.22 / 24.88	13.72 / 25.80	13.26 / 26.68	12.85 / 27.53	12.43 / 28.36	12.14 / 29.16	11.82 / 29.94	11.53 / 30.70	11.00 / 32.17	10.54 / 33.58	10.13 / 34.93	9.77 / 36.23	9.44 / 37.48
.32	16.67 / 22.64	16.21 / 23.28	15.78 / 23.91	15.27 / 24.72	14.69 / 25.70	14.17 / 26.64	13.70 / 27.55	13.28 / 28.43	12.89 / 29.29	12.53 / 30.12	12.21 / 30.92	11.90 / 31.71	11.36 / 33.23	10.88 / 34.68	10.46 / 36.07	10.09 / 37.41	9.75 / 38.71
.34	17.18 / 23.34	16.71 / 24.00	16.27 / 24.65	15.74 / 25.48	15.14 / 26.49	14.60 / 27.45	14.12 / 28.40	13.68 / 29.31	13.29 / 30.19	12.92 / 31.04	12.58 / 31.87	12.27 / 32.69	11.71 / 34.25	11.22 / 35.75	10.79 / 37.18	10.40 / 38.57	10.05 / 39.90
.36	17.68 / 24.01	17.19 / 24.70	16.74 / 25.36	16.19 / 26.22	15.58 / 27.26	15.03 / 28.26	14.53 / 29.22	14.08 / 30.16	13.67 / 31.05	13.29 / 31.93	12.95 / 32.80	12.63 / 33.63	12.05 / 35.24	11.54 / 36.78	11.10 / 38.26	10.70 / 39.68	10.34 / 41.06
.38	18.17 / 24.67	17.66 / 25.37	17.20 / 26.06	16.64 / 26.94	16.00 / 28.01	15.44 / 29.03	14.93 / 30.02	14.47 / 30.98	14.04 / 31.91	13.65 / 32.82	13.30 / 33.70	12.97 / 34.55	12.38 / 36.21	11.86 / 37.79	11.40 / 39.31	10.99 / 40.77	10.63 / 42.18
.40	18.64 / 25.31	18.12 / 26.03	17.65 / 26.73	17.07 / 27.64	16.42 / 28.73	15.84 / 29.79	15.32 / 30.80	14.84 / 31.79	14.41 / 32.74	14.01 / 33.67	13.65 / 34.57	13.31 / 35.45	12.70 / 37.15	12.17 / 38.77	11.70 / 40.33	11.28 / 41.83	10.90 / 43.28
.42	19.10 / 25.94	18.57 / 26.68	18.08 / 27.39	17.49 / 28.32	16.83 / 29.43	16.23 / 30.52	15.69 / 31.55	15.21 / 32.57	14.77 / 33.55	14.36 / 34.50	13.98 / 35.43	13.64 / 36.33	13.01 / 38.07	12.47 / 39.73	11.99 / 41.33	11.55 / 42.86	11.17 / 44.35
.44	19.55 / 26.55	19.01 / 27.30	18.51 / 28.04	17.90 / 28.99	17.22 / 30.14	16.61 / 31.24	16.06 / 32.31	15.57 / 33.34	15.11 / 34.34	14.70 / 35.31	14.31 / 36.26	13.96 / 37.18	13.32 / 38.95	12.76 / 40.67	12.27 / 42.30	11.83 / 43.87	11.43 / 45.39
.46	19.99 / 27.15	19.43 / 27.92	18.93 / 28.67	18.30 / 29.64	17.61 / 30.81	16.99 / 31.94	16.43 / 33.04	15.92 / 34.09	15.45 / 35.11	15.03 / 36.11	14.63 / 37.08	14.27 / 38.02	13.62 / 39.84	13.05 / 41.58	12.55 / 43.25	12.10 / 44.86	11.69 / 46.41
.48	20.42 / 27.71	19.85 / 28.52	19.33 / 29.29	18.70 / 30.28	17.99 / 31.48	17.35 / 32.63	16.78 / 33.75	16.26 / 34.82	15.78 / 35.87	15.35 / 36.88	14.95 / 37.87	14.58 / 38.84	13.91 / 40.70	13.33 / 42.47	12.81 / 44.18	12.36 / 45.82	11.94 / 47.41
.50	20.84 / 28.30	20.26 / 29.11	19.73 / 29.89	19.08 / 30.90	18.35 / 32.12	17.71 / 33.30	17.12 / 34.43	16.59 / 35.54	16.11 / 36.61	15.67 / 37.64	15.26 / 38.65	14.88 / 39.64	14.20 / 41.53	13.60 / 43.35	13.08 / 45.09	12.61 / 46.77	12.18 / 48.38
.52	21.25 / 28.86	20.66 / 29.68	20.12 / 30.48	19.46 / 31.51	18.72 / 32.76	18.06 / 33.96	17.46 / 35.12	16.92 / 36.24	16.43 / 37.33	15.98 / 38.39	15.56 / 39.42	15.17 / 40.42	14.48 / 42.36	13.87 / 44.21	13.34 / 45.98	12.86 / 47.69	12.43 / 49.34
.54	21.66 / 29.41	21.06 / 30.25	20.51 / 31.05	19.83 / 32.12	19.08 / 33.39	18.40 / 34.61	17.80 / 35.79	17.25 / 36.93	16.74 / 38.04	16.28 / 39.12	15.86 / 40.17	15.46 / 41.19	14.76 / 43.16	14.14 / 45.05	13.59 / 46.86	13.10 / 48.60	12.67 / 50.28
.55	22.05 / 29.95	21.44 / 30.80	20.88 / 31.63	20.20 / 32.70	19.43 / 34.00	18.74 / 35.24	18.12 / 36.45	17.56 / 37.61	17.05 / 38.74	16.58 / 39.84	16.15 / 40.91	15.75 / 41.95	15.03 / 43.96	14.40 / 45.88	13.84 / 47.72	13.35 / 49.49	12.90 / 51.21

Fig. 4

IVS SAMPLING RATE AND NOZZLE VELOCITY FOR 2.00 INCH DIAMETER NOZZLE
SCFM FLOW AND NOZZLE VELOCITY FOR GAS TEMPERATURES AT DEGREES FAHRENHEIT

FLOW RATE REGION	CFM/ FPS	CFM/ FPS	CFM/ FPS	CFM/ FPS	CFM/ FPS	CFM/ FPS	CFM/ FPS	CFM/ FPS	CFM/ FPS	CFM/ FPS	CFM/ FPS	CFM/ FPS	CFM/ FPS	CFM/ FPS	CFM/ FPS	CFM/ FPS	CFM/ FPS	CFM/ FPS
	60	90	120	160	210	260	310	360	410	460	510	560	660	760	860	960	1060	
.01	2.65 2.75	2.67 2.12	2.79 2.38	2.70 2.46	2.60 2.56	2.50 2.65	2.42 2.74	2.35 2.83	2.28 2.91	2.22 2.99	2.16 3.07	2.10 3.15	2.01 3.30	1.92 3.45	1.85 3.59	1.78 3.72	1.72 3.85	
.02	4.17 4.18	4.05 3.27	3.95 3.36	3.82 3.48	3.67 3.61	3.54 3.75	3.42 3.87	3.32 4.00	3.22 4.12	3.13 4.23	3.05 4.35	2.98 4.46	2.84 4.67	2.72 4.88	2.62 5.07	2.52 5.26	2.44 5.44	
.03	5.10 3.66	4.95 4.01	4.83 4.12	4.67 4.26	4.50 4.43	4.34 4.59	4.19 4.75	4.06 4.90	3.95 5.04	3.84 5.19	3.74 5.33	3.64 5.46	3.48 5.72	3.33 5.97	3.20 6.21	3.09 6.44	2.99 6.67	
.04	5.89 4.59	5.73 4.63	5.58 4.76	5.40 4.92	5.19 5.11	5.01 5.30	4.84 5.48	4.69 5.65	4.56 5.82	4.43 5.99	4.32 6.15	4.21 6.31	4.02 6.61	3.85 6.90	3.70 7.17	3.57 7.44	3.45 7.70	
.05	6.59 5.03	6.41 5.18	6.24 5.32	6.03 5.50	5.81 5.71	5.60 5.92	5.42 6.13	5.25 6.32	5.09 6.51	4.95 6.70	4.82 6.88	4.71 7.05	4.49 7.39	4.30 7.71	4.14 8.02	3.99 8.32	3.85 8.61	
.06	7.22 5.51	7.02 5.67	6.84 5.82	6.61 6.02	6.36 6.26	6.13 6.49	5.93 6.71	5.75 6.93	5.58 7.13	5.43 7.34	5.29 7.53	5.15 7.72	4.92 8.09	4.71 8.45	4.53 8.79	4.37 9.11	4.22 9.43	
.07	7.80 5.96	7.58 6.13	7.38 6.29	7.14 6.50	6.87 6.76	6.63 7.01	6.41 7.25	6.21 7.48	6.03 7.70	5.86 7.92	5.71 8.14	5.57 8.34	5.31 8.74	5.09 9.12	4.89 9.49	4.72 9.84	4.56 10.18	
.08	8.34 6.37	8.10 6.55	7.89 6.73	7.63 6.95	7.34 7.23	7.08 7.49	6.85 7.75	6.64 8.00	6.44 8.24	6.27 8.47	6.10 8.70	5.95 8.92	5.68 9.35	5.44 9.75	5.23 10.15	5.04 10.52	4.88 10.89	
.09	8.84 6.75	8.60 6.95	8.37 7.13	8.10 7.37	7.79 7.67	7.51 7.95	7.27 8.22	7.04 8.48	6.84 8.74	6.65 8.98	6.47 9.22	6.31 9.46	6.02 9.91	5.77 10.35	5.55 10.76	5.35 11.16	5.17 11.55	
.10	9.32 7.12	9.06 7.32	8.82 7.52	8.53 7.77	8.21 8.08	7.92 8.38	7.66 8.66	7.42 8.94	7.20 9.21	7.01 9.47	6.82 9.72	6.65 9.97	6.35 10.45	6.09 10.90	5.85 11.34	5.64 11.76	5.45 12.17	
.11	9.77 7.47	9.50 7.68	9.25 7.89	8.95 8.15	8.61 8.48	8.31 8.79	8.03 9.09	7.78 9.38	7.56 9.66	7.35 9.93	7.16 10.20	6.98 10.46	6.66 10.96	6.38 11.44	6.13 11.90	5.91 12.34	5.72 12.77	
.12	10.21 7.80	9.93 8.02	9.67 8.24	9.35 8.52	8.99 8.85	8.68 9.18	8.39 9.49	8.13 9.79	7.89 10.09	7.68 10.37	7.47 10.65	7.29 10.92	6.96 11.45	6.66 11.95	6.41 12.43	6.18 12.89	5.97 13.33	
.13	10.64 8.12	10.33 8.35	10.06 8.57	9.73 8.86	9.36 9.21	9.03 9.55	8.73 9.88	8.46 10.19	8.21 10.50	7.99 10.80	7.78 11.09	7.59 11.37	7.24 11.91	6.94 12.43	6.67 12.93	6.43 13.41	6.21 13.88	
.14	11.03 8.42	10.72 8.66	10.44 8.89	10.10 9.20	9.71 9.56	9.37 9.91	9.06 10.25	8.78 10.58	8.52 10.90	8.29 11.20	8.07 11.51	7.87 11.80	7.51 12.36	7.20 12.90	6.92 13.42	6.67 13.92	6.45 14.40	
.15	11.41 8.72	11.10 8.97	10.81 9.21	10.45 9.52	10.06 9.90	9.70 10.26	9.38 10.61	9.09 10.95	8.82 11.28	8.58 11.60	8.36 11.91	8.15 12.21	7.78 12.80	7.45 13.36	7.16 13.89	6.91 14.41	6.68 14.91	
.16	11.79 9.01	11.46 9.26	11.16 9.51	10.80 9.83	10.38 10.22	10.02 10.60	9.69 10.96	9.39 11.31	9.11 11.65	8.86 11.98	8.63 12.30	8.42 12.61	8.03 13.22	7.70 13.79	7.40 14.35	7.13 14.88	6.89 15.40	
.17	12.15 9.28	11.81 9.55	11.51 9.80	11.11 10.14	10.70 10.54	10.33 10.92	9.99 11.30	9.68 11.66	9.39 12.01	9.14 12.35	8.90 12.68	8.68 13.00	8.28 13.62	7.93 14.22	7.63 14.79	7.35 15.34	7.11 15.87	
.18	12.50 9.55	12.16 9.82	11.84 10.09	11.45 10.44	11.01 10.84	10.63 11.24	10.27 11.62	9.96 11.99	9.67 12.35	9.40 12.70	9.15 13.05	8.93 13.38	8.52 14.02	8.16 14.63	7.85 15.22	7.57 15.78	7.31 16.33	
.19	12.86 9.81	12.50 10.09	12.18 10.36	11.76 10.72	11.32 11.14	10.92 11.55	10.56 11.94	10.23 12.32	9.93 12.69	9.66 13.05	9.41 13.40	9.17 13.74	8.75 14.40	8.39 15.03	8.06 15.64	7.77 16.22	7.51 16.78	
.20	13.18 10.07	12.81 10.35	12.48 10.63	12.07 10.99	11.61 11.43	11.20 11.85	10.83 12.25	10.50 12.64	10.19 13.02	9.91 13.39	9.65 13.75	9.41 14.10	8.98 14.78	8.60 15.42	8.27 16.04	7.98 16.64	7.71 17.21	
.22	13.82 10.56	13.44 10.85	13.09 11.15	12.66 11.53	12.18 11.99	11.75 12.43	11.36 12.85	11.01 13.26	10.69 13.66	10.39 14.05	10.12 14.42	9.87 14.79	9.42 15.50	9.02 16.17	8.68 16.82	8.36 17.45	8.08 18.05	
.24	14.44 11.03	14.04 11.34	13.67 11.65	13.22 12.04	12.72 12.52	12.27 12.98	11.86 13.42	11.50 13.85	11.16 14.27	10.85 14.67	10.57 15.06	10.31 15.45	9.84 16.19	9.43 16.89	9.06 17.57	8.74 18.23	8.44 18.86	
.26	15.03 11.48	14.61 11.81	14.23 12.12	13.76 12.53	13.24 13.03	12.77 13.51	12.35 13.97	11.97 14.42	11.62 14.85	11.30 15.27	11.00 15.68	10.73 16.08	10.24 16.85	9.81 17.58	9.43 18.29	9.09 18.97	8.79 19.63	
.28	15.59 11.91	15.16 12.25	14.77 12.58	14.28 13.01	13.74 13.52	13.25 14.02	12.81 14.50	12.42 14.96	12.06 15.41	11.72 15.85	11.42 16.27	11.13 16.68	10.63 17.48	10.18 18.25	9.79 18.98	9.44 19.69	9.12 20.37	
.30	16.14 12.33	15.69 12.68	15.28 13.02	14.78 13.46	14.22 14.00	13.72 14.51	13.26 15.01	12.85 15.48	12.48 15.95	12.14 16.40	11.82 16.84	11.53 17.27	11.00 18.10	10.54 18.89	10.13 19.65	9.77 20.38	9.44 21.08	
.32	16.67 12.74	16.21 13.10	15.78 13.45	15.27 13.91	14.69 14.46	14.17 14.99	13.70 15.50	13.28 15.99	12.89 16.47	12.53 16.94	12.21 17.39	11.90 17.84	11.36 18.69	10.88 19.51	10.46 20.29	10.09 21.05	9.75 21.77	
.34	17.18 13.13	16.71 13.50	16.27 13.86	15.74 14.33	15.14 14.90	14.60 15.45	14.12 15.97	13.68 16.49	13.29 15.98	12.92 17.46	12.59 17.93	12.27 18.39	11.71 19.27	11.22 20.11	10.79 20.92	10.40 21.69	10.05 22.44	
.36	17.68 13.51	17.19 13.89	16.74 14.27	16.19 14.75	15.58 15.33	15.03 15.89	14.53 16.44	14.08 16.98	13.67 17.47	13.29 17.97	12.95 18.45	12.63 18.92	12.05 19.82	11.54 20.69	11.10 21.52	10.70 22.32	10.34 23.09	
.38	18.17 13.89	17.66 14.27	17.20 14.66	16.64 15.15	16.00 15.75	15.44 16.33	14.93 16.89	14.47 17.45	14.04 17.95	13.66 18.46	13.30 18.95	12.97 19.44	12.38 20.37	11.86 21.26	11.40 22.11	10.99 22.93	10.63 23.73	
.40	18.64 14.26	18.12 14.64	17.65 15.04	17.07 15.55	16.42 16.16	15.84 16.75	15.32 17.33	14.85 17.88	14.41 18.42	14.01 18.95	13.65 19.45	13.31 19.94	12.70 20.90	12.17 21.81	11.70 22.69	11.28 23.53	10.90 24.34	
.42	19.10 14.59	18.57 15.01	18.08 15.41	17.48 15.93	16.82 16.55	16.23 17.17	15.69 17.75	15.21 18.32	14.77 18.87	14.36 19.41	13.98 19.93	13.64 20.43	13.01 21.41	12.47 22.35	11.99 23.25	11.56 24.11	11.17 24.95	
.44	19.55 14.93	19.01 15.36	18.51 15.77	17.90 16.31	17.22 16.95	16.61 17.57	16.06 18.17	15.57 18.75	15.11 19.32	14.70 19.88	14.31 20.42	13.95 20.95	13.32 21.92	12.76 22.87	12.27 23.77	11.83 24.63	11.43 25.53	
.46	19.99 15.27	19.43 15.70	18.93 16.13	18.30 16.67	17.61 17.31	16.99 17.97	16.43 18.59	15.93 19.17	15.45 19.75	15.03 20.31	14.63 20.85	14.27 21.38	13.62 22.41	13.05 23.37	12.55 24.28	12.10 25.13	11.69 26.11	
.48	20.42 15.60	19.85 16.04	19.33 16.47	18.70 17.03	17.99 17.71	17.35 18.35	16.78 18.93	16.26 19.53	15.78 20.19	15.35 20.75	14.95 21.30	14.58 21.85	13.91 22.83	13.33 23.89	12.81 24.85	12.36 25.78	11.94 26.67	
.50	21.04 15.92	20.26 16.37	19.73 16.81	19.08 17.38	18.36 18.07	17.71 18.73	17.12 19.37	16.59 19.99	16.11 20.59	15.67 21.17	15.26 21.74	14.88 22.30	14.20 23.36	13.60 24.38	13.08 25.36	12.61 26.31	12.17 27.22	
.52	21.36 16.23	20.66 16.70	20.12 17.15	19.46 17.73	18.72 18.43	18.06 19.10	17.46 19.76	16.92 20.39	16.43 21.00	15.98 21.59	15.56 22.17	15.17 22.74	14.49 23.83	13.87 24.87	13.34 25.87	12.86 26.83	12.43 27.76	
.54	21.65 16.54	21.06 17.01	20.51 17.47	19.83 18.06	19.08 18.78	18.40 19.47	17.80 20.13	17.25 20.78	16.75 21.40	16.29 22.01	15.86 22.60	15.46 23.17	14.76 24.29	14.14 25.34	13.59 26.35	13.10 27.31	12.67 28.24	
.56	22.03 16.85	21.45 17.33	20.83 17.79	20.20 18.40	19.44 19.13	18.76 19.83	18.13 20.50	17.56 21.16	17.05 21.79	16.58 22.41	16.15 23.01	15.75 23.60	15.03 24.73	14.40 25.81	13.84 26.84	13.35 27.84	12.90 28.80	

Fig. 5

SCFM FLOW AND NOZZLE VELOCITY FOR GAS TEMPERATURES AT [illegible]

FLOW METER DELTA H	CFM/FPS 60	CFM/FPS 90	CFM/FPS 120	CFM/FPS 160	CFM/FPS 210	CFM/FPS 260	CFM/FPS 310	CFM/FPS 360	CFM/FPS 410	CFM/FPS 460	CFM/FPS 510	CFM/FPS 560	CFM/FPS 660	CFM/FPS 760	CFM/FPS 860	CFM/FPS 960	CFM/FPS 1060
.01	[illegible]	2.87	2.79	2.70	2.60	2.50	2.42	2.35	2.28	2.22	2.16	2.10	2.01	1.92	1.85	1.78	1.72
	[illegible]	1.48	1.52	1.57	1.64	1.70	1.75	1.81	1.86	1.92	1.97	2.02	2.11	2.21	2.30	2.38	2.46
.02	4.17	4.05	3.93	3.82	3.67	3.54	3.42	3.32	3.22	3.13	3.05	2.98	2.84	2.72	2.62	2.52	2.44
	2.04	2.10	2.15	2.23	2.31	2.40	2.48	2.56	2.64	2.71	2.78	2.85	2.99	3.12	3.25	3.37	3.48
.03	5.10	4.96	4.83	4.67	4.50	4.34	4.19	4.06	3.95	3.84	3.74	3.64	3.48	3.33	3.20	3.09	2.99
	2.50	2.57	2.64	2.73	2.83	2.94	3.04	3.13	3.23	3.32	3.41	3.50	3.66	3.82	3.98	4.12	4.27
.04	5.89	5.73	5.58	5.40	5.19	5.01	4.84	4.69	4.56	4.43	4.32	4.21	4.02	3.85	3.70	3.57	3.45
	2.88	2.96	3.04	3.15	3.27	3.39	3.51	3.62	3.73	3.83	3.94	4.04	4.23	4.41	4.59	4.76	4.93
.05	6.59	6.41	6.24	6.03	5.81	5.60	5.42	5.25	5.09	4.95	4.82	4.71	4.49	4.30	4.14	3.97	3.85
	3.22	3.31	3.40	3.52	3.66	3.79	3.92	4.05	4.17	4.29	4.40	4.51	4.73	4.93	5.13	5.32	5.51
.06	7.22	7.02	6.84	6.61	6.36	6.13	5.93	5.75	5.58	5.43	5.29	5.15	4.92	4.71	4.53	4.37	4.22
	3.51	3.63	3.73	3.85	4.01	4.15	4.29	4.43	4.57	4.69	4.82	4.94	5.18	5.41	5.62	5.83	6.03
.07	7.80	7.58	7.39	7.14	6.87	6.63	6.41	6.21	6.03	5.86	5.71	5.57	5.31	5.09	4.89	4.72	4.56
	3.81	3.92	4.03	4.16	4.33	4.49	4.64	4.79	4.93	5.07	5.21	5.34	5.59	5.84	6.07	6.30	6.52
.08	8.34	8.10	7.89	7.63	7.34	7.08	6.85	6.64	6.44	6.27	6.10	5.95	5.69	5.44	5.23	5.04	4.83
	4.08	4.19	4.30	4.45	4.63	4.80	4.96	5.12	5.27	5.42	5.57	5.71	5.98	6.24	6.49	6.73	6.97
.09	8.84	8.60	8.37	8.10	7.79	7.51	7.27	7.04	6.84	6.65	6.47	6.31	6.02	5.77	5.55	5.35	5.17
	4.32	4.45	4.57	4.72	4.91	5.09	5.26	5.43	5.59	5.75	5.90	6.05	6.34	6.62	6.89	7.14	7.39
.10	9.32	9.06	8.82	8.51	8.21	7.92	7.66	7.42	7.20	7.01	6.82	6.65	6.35	6.08	5.85	5.64	5.45
	4.56	4.69	4.81	4.98	5.17	5.36	5.54	5.72	5.89	6.06	6.22	6.38	6.69	6.98	7.26	7.53	7.79
.11	9.77	9.50	9.25	8.95	8.61	8.31	8.03	7.78	7.56	7.35	7.16	6.98	6.66	6.38	6.13	5.91	5.72
	4.78	4.91	5.05	5.22	5.42	5.62	5.82	6.00	6.18	6.36	6.53	6.69	7.01	7.32	7.61	7.90	8.17
.12	10.21	9.93	9.67	9.35	8.99	8.68	8.39	8.13	7.89	7.68	7.47	7.29	6.96	6.66	6.41	6.18	5.97
	4.99	5.13	5.27	5.45	5.67	5.87	6.07	6.27	6.46	6.64	6.82	6.99	7.33	7.65	7.95	8.25	8.53
.13	10.63	10.31	10.06	9.73	9.36	9.03	8.73	8.46	8.21	7.99	7.78	7.59	7.24	6.94	6.67	6.43	6.21
	5.20	5.34	5.49	5.67	5.90	6.11	6.32	6.52	6.72	6.91	7.10	7.28	7.62	7.96	8.28	8.58	8.88
.14	11.03	10.72	10.44	10.10	9.71	9.37	9.06	8.78	8.52	8.29	8.07	7.87	7.51	7.20	6.92	6.67	6.45
	5.39	5.54	5.69	5.89	6.12	6.34	6.56	6.77	6.97	7.17	7.36	7.55	7.91	8.26	8.59	8.91	9.22
.15	11.41	11.10	10.81	10.45	10.06	9.70	9.38	9.09	8.82	8.58	8.36	8.15	7.78	7.45	7.16	6.91	6.68
	5.58	5.74	5.89	6.09	6.33	6.57	6.79	7.01	7.22	7.42	7.62	7.82	8.19	8.55	8.89	9.22	9.54
.16	11.79	11.46	11.16	10.80	10.38	10.02	9.69	9.39	9.11	8.86	8.63	8.42	8.03	7.70	7.40	7.13	6.89
	5.76	5.93	6.09	6.29	6.54	6.78	7.01	7.24	7.45	7.67	7.87	8.07	8.46	8.83	9.18	9.52	9.85
.17	[illegible]	11.81	11.51	11.11	10.70	10.33	9.99	9.68	9.39	9.14	8.90	8.68	8.28	7.93	7.63	7.35	7.11
	5.94	6.11	6.27	6.49	6.74	6.99	7.23	7.46	7.68	7.90	8.11	8.32	8.72	9.10	9.47	9.82	10.16
.18	12.50	12.15	11.84	11.45	11.01	10.63	10.27	9.96	9.67	9.40	9.15	8.93	8.52	8.16	7.85	7.57	7.31
	6.11	6.29	6.46	6.68	6.94	7.19	7.44	7.68	7.91	8.13	8.35	8.56	8.97	9.36	9.74	10.10	10.45
.19	12.85	12.49	12.16	11.76	11.32	10.92	10.56	10.23	9.93	9.66	9.41	9.17	8.75	8.39	8.06	7.77	7.51
	6.28	6.46	6.63	6.86	7.13	7.39	7.64	7.89	8.12	8.35	8.58	8.80	9.22	9.62	10.01	10.38	10.74
.20	13.18	12.81	12.48	12.07	11.61	11.20	10.83	10.50	10.19	9.91	9.65	9.41	8.98	8.60	8.27	7.96	7.71
	6.44	6.63	6.81	7.04	7.31	7.58	7.84	8.09	8.33	8.57	8.80	9.02	9.46	9.87	10.27	10.65	11.02
.22	13.82	13.44	13.09	12.66	12.18	11.75	11.36	11.01	10.69	10.39	10.12	9.87	9.42	9.02	8.68	8.36	8.08
	6.76	6.95	7.14	7.39	7.67	7.95	8.22	8.49	8.74	8.99	9.23	9.47	9.92	10.35	10.77	11.17	11.55
.24	14.44	14.04	13.67	13.22	12.72	12.27	11.86	11.50	11.16	10.85	10.57	10.31	9.84	9.43	9.06	8.74	8.44
	7.06	7.26	7.45	7.71	8.01	8.31	8.59	8.86	9.13	9.39	9.64	9.89	10.36	10.81	11.25	11.65	12.07
.26	15.03	14.61	14.23	13.76	13.24	12.77	12.35	11.97	11.62	11.30	11.00	10.73	10.24	9.81	9.43	9.09	8.79
	7.35	7.56	7.75	8.02	8.34	8.65	8.94	9.23	9.50	9.77	10.03	10.29	10.78	11.25	11.71	12.14	12.56
.28	15.59	15.16	14.77	14.28	13.74	13.25	12.81	12.42	12.06	11.72	11.42	11.13	10.63	10.18	9.79	9.44	9.12
	7.62	7.84	8.05	8.33	8.65	8.97	9.28	9.57	9.86	10.14	10.41	10.68	11.19	11.68	12.15	12.60	13.04
.30	16.14	15.69	15.28	14.78	14.22	13.72	13.26	12.85	12.48	12.14	11.82	11.53	11.00	10.54	10.13	9.77	9.44
	7.89	8.12	8.31	8.62	8.96	9.29	9.60	9.91	10.21	10.50	10.78	11.05	11.58	12.09	12.57	13.04	13.49
.32	16.67	16.21	15.78	15.27	14.69	14.17	13.70	13.28	12.89	12.53	12.21	11.90	11.36	10.88	10.46	10.09	9.75
	8.15	8.38	8.61	8.90	9.25	9.59	9.92	10.24	10.59	10.84	11.13	11.42	11.96	12.48	12.99	13.47	13.94
.34	17.18	16.71	16.27	15.74	15.14	14.60	14.12	13.68	13.29	12.92	12.58	12.27	11.71	11.22	10.79	10.40	10.05
	8.40	8.64	8.87	9.17	9.54	9.89	10.22	10.55	10.87	11.18	11.47	11.77	12.33	12.87	13.39	13.88	14.36
.36	17.68	17.19	16.74	16.19	15.58	15.03	14.53	14.08	13.67	13.29	12.95	12.63	12.05	11.54	11.10	10.70	10.34
	8.65	8.89	9.13	9.44	9.81	10.17	10.52	10.86	11.18	11.50	11.81	12.11	12.69	13.24	13.77	14.29	14.78
.38	18.17	17.66	17.20	16.64	16.00	15.44	14.93	14.47	14.04	13.66	13.30	12.97	12.38	11.86	11.40	10.99	10.63
	8.89	9.13	9.38	9.70	10.08	10.45	10.81	11.15	11.49	11.81	12.13	12.44	13.04	13.60	14.15	14.68	15.19
.40	18.64	18.12	17.65	17.07	16.42	15.84	15.32	14.84	14.41	14.01	13.65	13.31	12.70	12.17	11.70	11.28	10.90
	9.11	9.37	9.62	9.95	10.34	10.72	11.09	11.44	11.79	12.12	12.45	12.76	13.37	13.95	14.52	15.06	15.58
.42	19.10	18.57	18.08	17.49	16.83	16.23	15.69	15.21	14.77	14.36	13.98	13.64	13.01	12.47	11.99	11.56	11.17
	9.34	9.60	9.86	10.20	10.60	10.99	11.36	11.73	12.08	12.42	12.75	13.08	13.70	14.30	14.88	15.43	15.96
.44	19.55	19.01	18.51	17.90	17.22	16.61	16.06	15.57	15.11	14.70	14.31	13.96	13.32	12.76	12.27	11.83	11.43
	9.56	9.83	10.09	10.44	10.85	11.25	11.63	12.00	12.36	12.71	13.05	13.39	14.03	14.64	15.23	15.79	16.34
.46	[illegible]	19.43	18.93	18.30	17.61	16.99	16.43	15.92	15.45	15.03	14.63	14.27	13.62	13.05	12.55	[illegible]	11.69
	9.77	10.05	10.32	10.67	11.09	11.50	11.89	12.27	[illegible]	12.99	13.35	13.69	14.34	14.97	15.57	16.15	16.71
.48	[illegible]	19.85	19.33	18.70	17.99	17.35	16.78	16.26	15.78	15.35	14.95	14.58	13.91	13.33	12.81	12.35	11.94
	[illegible]	10.27	10.54	10.90	11.33	11.75	12.15	12.54	12.91	13.28	13.63	13.98	14.65	15.29	15.90	16.50	17.07
.50	[illegible]	20.26	19.73	19.08	18.36	17.71	17.12	16.59	16.11	15.67	15.26	14.88	14.20	13.60	13.08	12.61	12.18
	[illegible]	10.48	10.76	11.13	11.56	11.99	12.40	12.79	13.17	13.55	13.92	14.27	14.95	15.61	16.23	16.84	17.42
.52	[illegible]	20.66	20.12	19.46	18.72	18.06	17.46	16.92	16.43	15.98	15.56	15.17	14.48	13.87	13.33	12.86	12.43
	[illegible]	10.69	10.97	11.35	11.79	12.23	12.65	13.05	13.45	13.82	14.19	14.55	15.25	15.91	16.55	17.17	17.76
.54	[illegible]	21.05	20.51	19.83	19.08	18.40	17.80	17.25	16.74	16.28	15.86	15.46	14.76	14.14	13.59	13.10	12.67
	[illegible]	10.89	11.18	11.56	12.02	12.46	12.89	13.30	13.70	14.09	14.46	14.83	15.54	16.22	16.87	17.50	18.10
.56	[illegible]	21.48	20.93	20.24	19.47	18.78	18.16	17.56	17.05	16.58	16.15	15.75	15.03	14.40	13.84	13.34	12.90
	[illegible]	11.09	11.39	11.77	12.24	12.69	13.12	13.54	13.95	14.34	14.73	15.10	15.82	16.52	17.18	17.82	18.43

Figure 1. Intermediate Volume Sampler
Method 18